Preface

The Cooperating Parties Group (CPG) has devoted substantial resources and has worked cooperatively with the United States Environmental Protection Agency (USEPA) and New Jersey Department of Environmental Protection (NJDEP) to prepare an Interim Remedy (IR) Feasibility Study (FS) for the upper 9 miles of the Lower Passaic River (LPR) on an accelerated basis. Considerable insights have been gained through this process and the purpose of this Statement is to share those insights with the National Remedy Review Board (NRRB) and the Contaminated Sediment Technical Advisory Group (CSTAG).

This statement is organized as follows:

Executive Summary

The IR for the Lower Passaic River Study Area's (LPRSA's) upper 9 miles was conceived to align remediation of the upper 9 miles with the lower 8.3 miles to maximize efficiency whilst limiting impact to the LPRSA communities. It aims to control internal (sediment) sources that inhibit recovery, thereby achieving a significant reduction in contaminants of concern (COC) exposure concentrations to be followed by natural recovery. It will incorporate Adaptive Management as a central element to ensure progress toward risk-based goals and a final remedy.

The sediments of the upper 9 miles are broadly categorized by recovery potential. Low recovery potential sediments tend to have 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) concentrations higher than those found on depositing water column particulates and high recovery potential sediments tend to have 2,3,7,8-TCDD concentrations[1] like those on depositing water column particulates. It is the low recovery potential sediments that account for the slowness of the overall system recovery and are the focus of the IR. They are "source" sediments and the aim of the IR is to remediate them, thereby reducing water column particulate concentrations and allowing the high recovery potential sediments to respond accordingly.

The upper bound 2,3,7,8-TCDD concentration of sediments within the high recovery potential category is in the range of 200 to 400 nanograms per kilogram (ng/kg). An important objective of the IR FS is to identify where within the range of 200 to 400 ng/kg to set a threshold for source sediments that efficiently achieves the source control objective of the IR.

One indication of this threshold is the transition between fine sediments and coarse sediments. Fine-grained sediments have been the focus of remediation in the LPR and the remedy for the lower 8.3 miles targets fine-grained sediments as the important sources inhibiting recovery. In the upper river, sediments with 2,3,7,8-TCDD concentrations above 260 ng/kg are largely fine sediments. As concentrations decline below this level the sediments become progressively coarser.

Other indications come from the numerical modeling of the four active remediation alternatives[2] examined in the FS. These alternatives have Remedial Action Levels (RALs) estimated from a base concentration map used in the FS that range from 346 to 164 ng/kg and they are compared using average results over a 10-year post-IR period. Remediating sediments above 346 ng/kg is predicted to reduce post-remedy 2,3,7,8-TCDD gross erosion flux from upper river sediments to the water column by almost 80%.[3] Little additional reduction in flux is attained by remediating lower concentration sediments, indicating that source sediments mainly have concentrations above 346 ng/kg. Confirmation

[1] On the bulk sediment for fine sediments or on the fine fraction of coarse sediments.

[2] Alternatives from the FS are as follows:
Alternative 1: No further action (NFA); Alternative 2: Targeted dredge and cap from river mile (RM) 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD Surface-Weighted Average Concentration (SWAC) of 85 ng/kg and polychlorinated biphenyl (PCB) RAL of 1 milligram per kilogram (mg/kg);
Alternative 3: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8 TCDD SWAC of 75 ng/kg and PCB RAL of 1 mg/kg;
Alternative 4: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD SWAC of 65 ng/kg and PCB RAL of 1 mg/kg;
Alternative 5: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8 TCDD SWAC of 125 ng/kg.

[3] This reduction and the others given here are less than the SWAC reduction meant to be achieved by each alternative due to factors such as the impact of dredging-induced resuspension and the impact of erosion-induced exposure of sub-surface concentrations.

of this conclusion comes from the predicted reduction in the 2,3,7,8-TCDD concentrations on depositing particles achieved by controlling sources, which facilitates post-remedy recovery by diluting the concentrations of unremediated sediments. Remediating sediments above 346 ng/kg reduces post-remedy 2,3,7,8-TCDD concentrations of depositing particles by 72% and minimal additional reduction is attained by remediating lower concentration sediments.

Purely based on source control and recovery potential, sediments with concentrations greater than 346 ng/kg are the targets of an IR for source control. However, such an alternative (termed Alternative 5 in the FS) cannot be chosen because it achieves a post remedy Surface-Weighted Average Concentration (SWAC) of 125 ng/kg and not the 85 ng/kg embodied in the IR's Remedial Action Objective (RAO) 1. The next larger alternative evaluated in the FS (termed Alternative 2) meets the RAO SWAC goal and has a nominal RAL of 260 ng/kg, thus targeting mainly fine sediments. The two larger alternatives evaluated (Alternatives 3 and 4) expand targeting to coarser sediments and achieve little additional source control beyond that of Alternative 2. Moreover, an assessment of post-remedy recovery rate that relies on model projections shows that the rate of recovery achieved by Alternative 2 matches the rates attained by Alternatives 3 and 4.

The FS evaluation of the Alternatives against the National Contingency Plan (NCP) threshold and balancing criteria concluded that Alternative 2 is preferable to the larger alternatives. Although all three meet the threshold criteria, Alternative 2 achieves long-term effectiveness and permanence without the ineffective additional remediation incurred with the larger alternatives. It also ranks higher in short-term effectiveness and implementability. For these reasons, the CPG recommends that Alternative 2 be chosen as the source control IR.

The CPG further recommends that USEPA reconsider and revise RAO 1 to specify a RAL because it is directly measurable and objective, and it does not pose the challenges associated with a post-remedy SWAC. Post-remedy efforts to judge whether the remedy achieved RAO 1 SWAC goals may be fruitless and are inferior to other lines of evidence to determine whether all actionable source sediments have been remediated. If USEPA maintains the RAO 1 SWAC goals and mandates using post-remedy sediment data to judge whether the remedy achieved them, the procedures laid out in this statement, which largely follow USEPA's July 2019 Decision Tree Narrative, should be followed.

1 The Goal of the Interim Remedy is Source Control

In March 2016, USEPA selected a final action for the lower 8.3 miles of the LPRSA. Design of this remedy is underway with construction slated to begin in 2022. The IR for the LPRSA's upper 9 miles was conceived to align remediation of the upper 9 miles with the lower 8.3 miles to maximize efficiency whilst limiting impact to the LPRSA communities. In recognition of unresolved uncertainties, remediation in the upper 9 miles would occur in a phased approach within an Adaptive Management construct. The IR is the first phase and aims to control internal (sediment) sources that inhibit recovery, thereby achieving a significant reduction in COC exposure concentrations to be followed by natural recovery. It is based on a conceptual understanding of source sediments and river recovery.

The Remedial Investigation (RI) Report (Anchor QEA 2019)[4] presents a conceptual model in which sediments are categorized by recovery potential. Low recovery potential is exhibited by sediments subject to net erosion or cyclical erosion-deposition that brings higher subsurface concentrations into the surface layer. High recovery potential is exhibited by sediments subject to significant net deposition or cyclic erosion-deposition of the fine sediment component of coarse sediments that does not expose buried higher concentration sediments. Low recovery potential sediments tend to have 2,3,7,8-TCDD concentrations higher than those found on depositing water column particulates while high recovery potential sediments tend to have 2,3,7,8-TCDD concentrations[5] like those on depositing water column particulates. It is the low recovery potential sediments that account for the slowness of the overall system recovery and are the focus of the IR. Given their higher concentration and susceptibility to erosion, these sediments control water column particulate concentrations and, when deposited, the concentrations on sediments with high recovery potential. For this reason, the low recovery potential sediments are "source" sediments and the aim of the IR is to remediate them, thereby reducing water column particulate concentrations and allowing the high recovery potential sediments to respond accordingly.

Various lines of evidence were used in the RI Report to investigate the 2,3,7,8-TCDD concentration characteristic of high recovery potential sediments:

- A 2007 to 2008 USEPA study of recently deposited sediment found 2,3,7,8-TCDD between 200 and 300 ng/kg in the lower 8 miles and 460 and 540 ng/kg for the two samples collected between about river mile (RM) 8 and RM 12.
- Surface sediment 2,3,7,8-TCDD concentrations measured between 2005 to 2010 in the RM 1 and RM 7 reach at depositional locations averaged 260 ng/kg.
- Sediment depositing on the cap placed to complete the RM 10.9 Removal Action had 2,3,7,8-TCDD concentrations that averaged 210 ng/kg.
- Sediment cores between RM 8.3 and RM 15 with surface layer concentrations between 200 and 300 ng/kg mostly exhibit vertical profiles of 2,3,7,8-TCDD concentrations indicative of significant net deposition and thus high recovery potential.

[4] Anchor QEA, 2019. *Remedial Investigation Report*. Lower Passaic River Study Area Remedial Investigation/Feasibility Study. Prepared for the Lower Passaic River Cooperating Parties Group. July 2019.
[5] On the bulk sediment for fine sediments or on the fine fraction of coarse sediments.

- Surface sediments between RM 8.3 and RM 15 with less than 200 ng/kg 2,3,7,8-TCDD exhibit a range of carbon-normalized 2,3,7,8-TCDD concentrations within the range of water column particulate concentrations, suggesting close connection with the water column and thus high recovery potential for these sediments that tend to be coarse overall.

These data support a conclusion that the upper bound 2,3,7,8-TCDD concentration of sediments with high recovery potential is in the range of 200 to 400 ng/kg. Sediments with higher concentrations likely have lower recovery potential and are identified as source sediments. An important objective of the IR FS (Integral et al. 2019[6]) is to identify where within the range of 200 to 400 ng/kg to set a threshold for source sediments that efficiently achieves the source control objective of the IR. The active alternatives being evaluated in the FS cover this range, as shown by the surface sediment RALs[7] (Table 1) corresponding to their respective SWAC goals, with Alternative 4 (65 ng/kg SWAC) being somewhat below the bottom of the range.

Table 1
IR FS Active Remedial Alternatives SWAC Goals and Derived Remedial Action Levels

Alternative	2,3,7,8-TCDD RM 8.3 to RM 15 SWAC Goal (ng/kg)	2,3,7,8-TCDD Surface Sediment RAL (ng/kg)[1]
2	85	260
3	75	205
4	65	164
5	125	346

Note:
1. RALs derived from the base map used in the FS (Conditional Simulation Map 37).

The source sediment targeting of the alternatives is illustrated in Figure 1. All the active alternatives target the definitive source sediments. The likelihood of targeting high recovery potential sediments increases (i.e., greater penetration into the uncertainty band) as the SWAC goal decreases and the RAL drops. Of note, the 65 ng/kg alterative (Alternative 4) targets a portion of the high recovery potential sediments.

Further insight on the additional targeting that occurs as the RAL is lowered comes from examining the type of sediment targeted. As discussed in the Record of Decision (ROD; USEPA 2016)[8] for the lower 8.3 miles, the extent of the selected remedy is based in large measure on the conclusion that the fine-grained sediments are the important sources. Conversely, coarse sediments have not typically been identified as source sediments.

Figure 2 compares the fine sediment fraction of the sediments that would be removed under each alternative. In samples between RM 8.3 and RM 15 with 2,3,7,8-TCDD concentrations at or above the

[6] Integral, 2019. *Draft Upper 9-Mile Source Control Interim Remedy Feasibility Study*. Lower Passaic River Study Area Remedial Investigation and Feasibility Study. August 12, 2019.
[7] The RALS for each alternative are specific to the 2,3,7,8-TCDD concentration mapping used. For the purpose of the FS, a map was adopted that has central tendency characteristics among 100 maps developed using conditional simulation. It is termed Conditional Simulation (CS) map 37.
[8] USEPA (U.S. Environmental Protection Agency), 2016. *Record Of Decision.* Lower 8.3 Miles of the Lower Passaic River Part of the Diamond Alkali Superfund Site Essex and Hudson Counties, New Jersey. USEPA, Region II. March 6, 2016.

Alternative 5 RAL of 346 ng/kg, the average percent fines is about 60%, which is characteristic of the fine sediment deposits in the river (also shown in Figure 2). The additional samples that would be targeted at the Alternative 2 RAL of 260 ng/kg also have an average percent fines of about 60%. Below 260 ng/kg, the percent fine sediment is lower. The additional samples that would be targeted at the Alternative 3 RAL of 205 ng/kg average 40% fines. Moving to the Alternative 4 RAL of 164 ng/kg, the additional samples average 33% fines. Thus, Alternatives 3 and 4 extend targeting to coarser sediments that are not likely source sediments.

Source control greatly reduces average surface sediment concentrations, thereby greatly reducing the mass flux of COCs from the sediments, COC flux through the water column and COC concentrations on water column particulate matter depositing on the non-source sediments, which accelerates recovery. As shown in Table 2, the SWAC goals of Alternatives 2, 3, and 4 constitute greater than 90% reduction in SWAC from the value estimated from the COC mapping.

Table 2
2,3,7,8-TCDD SWAC Goals to be Attained by Each Remedial Alternative and Percent Reduction from Current SWAC Between RM 8.3 and RM 15

Alternative	SWAC Goal (ng/kg)	Percent Reduction from Current SWAC of 990 ng/kg[1]
2	85	91
3	75	92
4	65	93
5	125	87

Note:

1. Current SWAC based on base map used in the FS (Conditional Simulation Map 37). Percent reductions at SWAC goal. FS report shows slightly greater reductions because additional remediation to address RAO 2 drives SWAC below the goal.

The acceleration in recovery achieved by remediating source sediments is estimable from FS model projections that simulated the remediation period and 10 years post remediation. While the specific numerical results of these projections are subject to considerable uncertainty, most significantly because the model lacks the spatial resolution to represent remediation of sub-cell areas, they do provide a good sense of the relative acceleration of recovery among the alternatives.

With no further action in the upper 9 miles and only the remediation of the Lower 8 miles, the SWAC drops slowly over the 10-year post-IR period from about 720 to about 620 ng/kg, suggesting it would take over 40 years for concentration to reduce by half. In contrast, Alternative 2 would achieve a concentration of about 53 ng/kg during the 10 years post-remedy, based on the results of model runs that explicitly account for capping. Assuming the SWAC goal of 85 ng/kg is achieved at the end of remediation, a drop to 53 ng/kg implies that it would take 14 years for the concentration to drop in half.[9] Thus, source control in the upper 9 miles is expected to significantly accelerate the rate of

[9] At the end of active remediation, model predicted concentration are sensitive to the assumed resuspension during dredging. Assuming a SWAC of 85 ng/kg effectively discounts resuspension impacts and avoids confounding long-term recovery with recovery from the impacts of resuspension. Additional discussion of recovery metrics is provided in Section 2.2.3.

recovery (as measured by half time) in the decade following IR completion, further enhancing the concentration reduction that it initially achieves. A more detailed discussion of recovery for all the alternatives is presented in Section 2.

Recovery is expected to continue post-remedy and its progress will be tracked with long-term monitoring. The recovery achieved by the IR may be enough to achieve remedial goals. If the rate of progress is deemed insufficient, enhanced recovery options will be evaluated through the adaptive management process.

Adaptive management will be an essential component of the IR to ensure that the remedial goals to be specified in a second, final ROD will be met. Incorporating structured adaptive management into the remediation ensures that data collected during the monitoring phase of the project would be used to reduce uncertainties and establish an efficient and protective final remedy for the LPRSA.

Three primary adaptive elements have been identified for the upper 9 miles of the LPRSA:

- Adaptive Element 1: Preliminary Remediation Goals (PRGs)/Remediation Goals (RGs) development and refinement
- Adaptive Element 2: Overall system response
- Adaptive Element 3: Recovery assessment to attain PRGs/RGs

The adaptive elements are key project activities and milestones that are accompanied by decision points that may trigger one or more adaptive responses. The adaptive management framework links each adaptive element to associated decision questions, to the relevant time frame(s) for decisions, key information inputs, and decision-making criteria (Table 3) to guide a systematic decision-making process.

Key information to support the implementation of adaptive management would be provided by sampling and monitoring activities that have been performed to support the RI/FS, those that are underway to characterize current conditions, and those that would be performed during remedial design (RD), IR implementation, and post-IR monitoring. Currently available data were used to develop the CSM that provides the basis for the IR and subsequent data will be used to confirm or refine system understanding and recovery projections.

Following the completion of the IR, a post-IR monitoring program will be implemented to evaluate site recovery and ultimately ensure that final RGs are met within a reasonable time frame. Post-IR monitoring will include water column, tissue, and sediment, as well as data collected to reduce uncertainty in key variables in the PRG calculations. These data can address the numerous uncertainties that relate to establishing and refining sediment PRGs, selecting final RGs, understanding the responses of the system to an IR, and estimating recovery time frames needed to attain PRGs and final RGs. The refined understanding will support adaptive decision making to most efficiently achieve the overall objectives for the site.

Table 3
LPRSA Upper 9-Mile Adaptive Management Decision Framework

Adaptive Element	Decision Question	Decision Time Frame(s)	Key Inputs	Decision Criteria
1. PRG/RG Development and Refinement	Is uncertainty in the key variables that influence PRGs adequately constrained?	In parallel with IR remedial design Refinement at 5-year reviews, as warranted Set final RGs in final Record of Decision	CFT model and FWM Empirical data on sediment and tissue interactions Exposure information Toxicity criteria	• Identify the PRG input variables with the greatest uncertainty when PRGs are first established (i.e., in parallel with remedial design) • Evaluate whether new information warrants PRG refinement at 5-year reviews • Refine PRGs and present to decision makers, with information on uncertainty factors
2. Overall System Response	Is the response of the system to the source control IR consistent with the CSM and numerical models?	In conjunction with 5-year reviews	• Long-term monitoring – Tissue – Water column – Sediment – Bathymetry • Trend analysis • Model projections	• Define anticipated recovery time frames during remedial design, based on refined CSM and numerical models • Trigger diagnostic assessment if observed recovery is inconsistent with expected recovery • Refine CSM and/or numerical models, as warranted
3. Recovery Assessment to Attain PRGs/RGs	Is recovery progressing in media of concern to reach protective levels of risk-driving COCs within a reasonable time frame?	In conjunction with 5-year reviews	• PRGs – Long-term monitoring data – Tissue • Water column • Trend analysis • Sediment–tissue interactions • Model projections • Recovery acceptability criteria	• Define acceptable recovery time frames when PRGs are developed and/or refined • Trigger diagnostic assessment if observed recovery is inconsistent with expectations • Recommend possible response options to decision makers based on diagnostic assessment outcomes

Notes:
CFT: contaminant fate and transport
COC: contaminant of concern
CSM: conceptual site model
FWM: food web model
IR: interim remedy
PRG: preliminary remediation goal
RG: remediation goal

2 Alternative 2 Achieves Source Control and There is Little Benefit Accrued by the Additional Remediation Under Alternatives 3 and 4

The IR is a source control remedy. This is plainly evident in two of its three RAOs:

- Control the sediment sources of 2,3,7,8-TCDD and total polychlorinated biphenyls (PCBs) by remediating surface sediment source areas containing elevated concentrations (RAO 1)
- Control subsurface sediments from becoming sources of 2,3,7,8-TCDD and total PCBs by remediating sediments between RM 8.3 and RM 15 that have a demonstrated potential for erosion to expose subsurface concentrations above defined subsurface remedial action levels (RAO 2)

The third objective is also indirectly related to source control, though that tie is not evident in its language:

- Achieve a post-IR 2,3,7,8-TCDD SWAC from RM 8.3 to RM 15 of not more than 85 ng/kg, and a post-IR total PCB SWAC from RM 8.3 to RM 15 that is at or below the established total PCB background concentration of 0.46 milligrams per kilogram (mg/kg) (RAO 1)

These post-IR SWACs come from an early desktop analysis[10] of what would be achieved by a source control alternative in which the total PCB RAL was set at 1 mg/kg and the 2,3,7,8-TCDD RAL was set at 300 ng/kg, which is the mid-point of the uncertainty band of the threshold for source sediments discussed in Section 1. Another way to consider the SWAC objectives is in the context of source control achieved by meeting them.

Five remedial alternatives are evaluated in the draft IR FS (discussed in Table 1 but provided here for completeness)[11]:

- Alternative 1: No further action (NFA)
- Alternative 2: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD SWAC of 85 ng/kg and PCB RAL of 1 mg/kg
- Alternative 3: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD SWAC of 75 ng/kg and PCB RAL of 1 mg/kg
- Alternative 4: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD SWAC of 65 ng/kg and PCB RAL of 1 mg/kg

[10] Later desktop analyses on which the remedial alternatives in the FS are based assumed a greater residual concentration in remediated areas, which is why the alternative with a post-remedy 2,3,7,8-TCDD SWAC of 85 ng/kg has a RAL of 260 ng/kg.

[11] The technical specifications of the remedial alternatives (e.g., footprints, volumes, construction durations) were developed in the IR FS using a representative base map of surface and subsurface sediment concentrations of 2,3,7,8-TCDD and total PCBs. This map was developed using a geostatistical interpolation procedure known as conditional simulation to generate 100 equally probable maps of surface (0 to 0.5 feet) and subsurface (0.5 to 1.5 feet) concentration distributions of the LPR sediment bed. From these maps, a base map representing the central tendency of the 100 maps was selected and used to delineate remedial footprints needed to meet the specifications of each IR FS alternative. The 100 maps provide a range on the footprints and volumes for each of the alternatives.

- Alternative 5: Targeted dredge and cap from RM 8.3 to RM 15 to attain a post-IR 2,3,7,8-TCDD SWAC of 125 ng/kg.

Ranking the alternatives by the SWACs to be attained (125 ng/kg; 85 ng/kg; 75 ng/kg; 65 ng/kg) is not appropriate for a remedy meant to control the sources inhibiting recovery. Rather, in evaluating the alternatives there are two key questions:

1. Does the alternative meet the threshold criteria of being protective of public health and the environment and meeting Applicable or Relevant and Appropriate Requirements (ARARs)? For the purpose of the IR, this means:
   a. Does the IR alternative provide the ability to progress toward overall protection, and does it achieve the RAOs that have been established; and
   b. Does the IR alternative provide the ability to achieve ARARs?
2. When comparing the alternatives using the balancing criterion of long-term protectiveness and permanence, does an alternative provide meaningful additional source control? As noted in Section 1, a greater reduction in SWAC does not equate to additional source control if non-source sediments are targeted to achieve the lower SWAC.

2.1 Approach to Evaluating Source Control

Evaluating the remedies on the basis of source control is accomplished by considering the metrics in Table 4. These metrics are outputs of coupled numerical models of hydrodynamics, sediment transport, organic carbon transport and contaminant fate and transport used to project concentration trends for an 18-year period that covers active remediation and the 10 years thereafter. The accuracy of these projections is hampered by framework and parameter uncertainties that are discussed in the RI report. Because any projection is inaccurate, the FS focuses on the range of results produced by multiple projections meant to evaluate the impacts of certain sources of uncertainty and does not rely on predicted point values in making comparisons among alternatives.[12]

Table 4
Source Control Metrics for RM 8.3 to RM 15 Used to Compare Remedial Alternatives

2,3,7,8-TCDD Metric	Represents
Gross erosion flux from sediment	Sediment source strength
Concentration on depositing particles	Key to recovery via deposition resulting from source control
Post-remedy recovery rate	The benefit to natural recovery of source control
Net flux to the lower 8.3 miles	Source to the lower 8.3-mile Focused Feasibility Study Reach
Water column concentration	Exposure to pelagic biota resulting from sediment sources

[12] CPG (Cooperating Parties Group), 2019. Regarding the Use and Limitations of Model Projections in Evaluating and Comparing Remedial Alternatives in the IR FS. Submitted to USEPA and approved on March 21, 2019.

Three sources of uncertainty were considered:

- Representation of the change in bed properties that results from post-dredging capping
- The layout of the remedial footprints derived from uncertainty in bed COC concentration mapping
- The fraction of dredged solids and contaminant released to the river during dredging

The first is a source of uncertainty because the model's spatial resolution is too crude to represent the change in bed properties (composition, bulk density, and erodibility) at the scale capping would occur. The second is a source of uncertainty because the sediment data are too sparse to characterize the sediment COC concentrations throughout the river bottom and efforts at interpolation have yielded many plausible concentration maps. However, this uncertainty was found to only slightly impact modeled post-remedy concentration trends. The third is a source of uncertainty because the likely release of solids and contaminant is unknown and based on experience at other sites the fraction might be as low as 1% or as high as 3%.

Two bounding scenarios were modeled to address the change in bed properties issue. At one bound, the change in bed properties in capped areas of the IR was ignored and the contaminant fate model used the NFA sediment transport model results for all the active remediation alternatives. These simulations also ignored the IR solids release associated with the contaminant release due to dredge resuspension. At the other bound, the sediment transport model changed the bed properties of a model grid element if more than 50% of its area was remediated (including changing the properties of the portion of the grid element that was not remediated). These simulations also simulated the IR solids release associated with the dredge resuspension contaminant release. Both scenarios are not correct, but likely bracket what would be obtained if the change in bed properties in capped areas could be properly represented. Two scenarios were modeled to address the uncertainty in dredging-induced release; 1% and 3%.

Projections were not conducted for all combinations of scenarios due to schedule limitations and the long times involved in completing a projection. The active remedial alternative projections conducted are shown in Table 5.[13]

[13] The NFA scenario was modeled using the base map and representation of remediation in the lower 8.3 miles accounting for erodibility change and assuming 3% release.

Table 5
Model Projections Conducted in Support of the Feasibility Study

Scenario	Remedial Alternatives Modeled			
	125 ppt	85 ppt	75 ppt	65 ppt
Base map; No capping bed properties change; 3% contaminant release with no solids release	√	√	√	√
Base map; No capping bed properties change; 1% contaminant release with no solids release			√	
Base map; capping bed properties change; 3% contaminant and solids release		√	√	√
Base map; capping bed properties change; 1% contaminant and solids release			√	
Alternative maps; No bed properties change; 3% contaminant release with no solids release			√	

Note:
ppt: parts per thousand

The model metrics presented in this Statement (see Table 4), which are newly developed and not included in the draft FS submitted to USEPA in August 2019, are single values reflective of one scenario rather than a range across scenarios. This was done because comparing across all alternatives is limited to the scenario using the base map, with capping bed properties change ignored and 3% release. For the recovery rate metric, the scenarios with capping bed properties change are used for reasons presented in the discussion of these rates. The model results are useful for making relative comparisons among alternatives and such comparisons are the focus of the evaluations of the metrics in Table 4.

2.2 Findings from Source Control Assessment

As detailed below, the source control metrics show that most of the source control is achieved by a RAL of 346 ng/kg (Alternative 5). Small increments of source control are added by the lower RALs associated with the other active alternatives. As such, all the active IR alternatives meet the threshold criterion of providing the ability to progress towards overall protection, but Alternative 5 does not meet RAO 1, which specifies a SWAC from RM 8.3 to RM 15 of not more than 85 ng/kg. Because Alternative 5 does not achieve the threshold criteria, consideration of Alternatives 2, 3, and 4, which do meet all threshold criteria, is required.

The analysis below supports selection of Alternative 2 because it meets all threshold criteria and provides a similar degree of long-term effectiveness and permanence as Alternatives 3 and 4. Based on the objective metrics presented in Table 4, going from a RAL of 346 ng/kg (Alternative 5) to 260 ng/kg (Alternative 2) achieves only a small amount of additional source control. Still less additional source control is achieved by moving to the lower RALs of Alternatives 3 and 4. Specifically, in comparison to the NFA alternative, Alternatives 2, 3, and 4:

- Provide a similar degree of reduction in 2,3,7,8-TCDD erosion flux from sediments in the upper 9 miles
- Result in nearly equivalent 2,3,7,8-TCDD concentration on depositing particles

- Accelerate post-remedy recovery rates to similar levels
- Provide a similar degree of reduction in downstream 2,3,7,8-TCDD flux
- Achieve a similar degree of reduction in 2,3,7,8-TCDD water column concentrations

The metrics are discussed in a logical sequence. Remediation reduces the flux of chemical from sediments to the water column. The reduced flux results in much lower chemical concentrations on particles depositing on the sediments. This reduction accelerates recovery in two ways. First, concentrations in surface sediments drop as they accumulate the lower concentration solids. Second, the drop in surface sediment concentrations causes the concentrations on depositing particles to be further reduced, thereby setting up a positive feedback loop that fuels additional recovery by accelerating the downward trend in sediment concentrations. Additional benefits of this process are the reductions in water column concentrations to which pelagic organisms are exposed and reductions in the export of contaminant from the upper 9 miles to the lower 8 miles and Newark Bay.

2.2.1 Gross Erosion Flux from Sediment

The performance of the IR alternatives in achieving source control is shown in Figure 3a via the average model-predicted 2,3,7,8-TCDD erosion flux over the 10-year period following completion of the IR.[14]

As described in the RI report, erosion is the principle mechanism for contaminants from internal sources to enter the water column and redistribute to other areas. During low freshwater flow conditions, erosion is mainly limited to a thin layer of unconsolidated material, termed the fluff layer, that is eroded and re-deposited by tidal currents on an ongoing basis and strongly influences the contaminant concentration in the water column. During intermittent high freshwater flow conditions, sediments beneath the fluff layer are more likely to be eroded and may carry with them higher contaminant concentrations. By integrating the resuspension flux over time, the aggregate post-remedy contribution of the sediments to the water column can be assessed for each of the IR FS alternatives (the influence of the eroded contaminant on water column and sediment concentrations and export to the lower river is considered in later metrics).

It is evident in Figure 3a that even the smallest of the active remedy alternatives (Alternative 5) achieves substantial source control. With its RAL of 346 ng/kg, the cumulative 2,3,7,8-TCDD resuspension flux of 2.5 grams per year (g/y) is five-fold (78%) lower than would be realized under NFA (Alternative 1), which is predicted to contribute approximately 12 g/y to the water column. Reducing the RAL by 25% to 260 ng/kg in Alternative 2 reduces the flux by an additional 1.5% (0.19 g/y). Further reductions of the RAL have a progressively smaller impact reflecting a declining influence of lower concentration sediments on the aggregate sediment source; a RAL of 205 ng/kg (Alternative 3) reduces the flux by another 1% (0.12 g/y) and a RAL of 164 ng/kg (Alternative 4) further reduces the flux by only 0.2% (0.02 g/y). Therefore, nearly all of the source control is achieved by Alternative 5 RAL of 346 ng/kg and further

[14] This quantity reflects the product of the sediment mass resuspended to the water column and the contaminant concentration sorbed to the resuspended particles, summed over each model grid cell between RM 8.3 and RM 15, accumulated for the full 10-year post-remedy period and then annualized to units of grams per year.

reductions in the RAL yield marginal benefits in reducing erosion flux. Based on this metric, all the active alternatives provide a similar degree of long-term effectiveness and permanence.

2.2.2 Concentration on Depositing Particles

One of the expected benefits of the IR source control is that recovery in surface sediments of non-target areas will be enhanced due to a reduced concentration on depositing particles. As described in Section 1, depositing particle concentrations influence the surface sediments either by net deposition or cyclic erosion-deposition, and their concentrations will on average be reduced as the source of contaminant to the water column is controlled (mainly the sediment erosion flux described previously).

This reduction in depositing particle 2,3,7,8-TCDD concentration is shown in Figure 3b, considering only the fine sediment fraction (clays and silts) that sorbs the majority of the contaminant.[15] The average depositing particle concentration is here estimated for each alternative as the ratio of the total chemical deposition flux to the total fine (cohesive) sediment deposition flux over the 10-year post-remedy period. Relative to the NFA scenario (Alternative 1), all active IR alternatives are projected to achieve, on average, more than a 70% reduction in the depositing 2,3,7,8-TCDD concentrations. This reduction varies marginally among the alternatives; it is about 73% (86 ng/kg) for Alternative 5 and Alternatives 2, 3, and 4 incrementally reduce the concentration further by 1.8%, 1.1%, and 0.2%, respectively, as lower concentration sediments are targeted. Source control is achieved by Alternative 5 and further reductions in the RAL yield marginal benefit in reducing the 2,3,7,8-TCDD concentrations on depositing particles. Again, this metric shows that Alternatives 2, 3, and 4 provide a similar degree of long-term effectiveness and permanence.

2.2.3 Post-Remedy Recovery Rate

The post-remedy concentration trends of the FS model projections depend on the impacts of dredging-induced resuspension, which are driven by the assumed resuspension rate, whether solids are released to the water column in addition to chemical, and whether bed properties are altered to approximately account for post-dredging capping. The resuspension effect is greatest in projections that do not take account of post-dredging capping and solids release (these simulations were used as the base runs presented in the draft FS). For the projections that account for post-dredging capping and solids release, the resuspension effect is minimal by the end of the projection period 10 years post-remedy.[16] Thus, these projections are taken as end points for a recovery rate calculation that is relatively unaffected by resuspension assumptions.[17]

A recovery rate calculation starting point concentration that is elevated by the assumed resuspension would yield an elevated rate of recovery that reflects recovery from resuspension impacts and is not indicative of longer-term recovery. This is illustrated for Alternative 3 (SWAC goal of 75 ng/kg) in

[15] In the RI/FS contaminant fate and transport (CFT) model, contaminant sorbs exclusively to the fine (cohesive) sediment classes.

[16] This can be seen in the Alternative 3 projections with 3% and 1% resuspension, which have nearly identical 10-year post-remedy concentrations of 48 and 46 ng/kg.

[17] Accounting for post-dredging capping results in somewhat different concentration trends than the projections absent this capping, reflecting model uncertainty and why results should be looked at in a relative sense, not an absolute sense.

Table 6, which compares half-times[18] based on concentration change over the 10-year post-remedy period for projections with 3% and 1% resuspension.

Table 6
Comparison of 2,3,7,8-TCDD Half-Times for Alternative 3 Based on Concentration Changes for Different Resuspension Simulations

Scenario	Half Time (y) with 3% Resuspension	Half Time (y) with 1% Resuspension
No capping or solids release	8	16
Capping and solids release	9	14

To avoid the bias of recovery from resuspension impacts, the starting point concentration is here presumed to be the attainment goal of the alternative being considered. The validity of this presumption is supported by a projection that uses 1% resuspension rather than the 3% resuspension used for most of the projections. That projection, which is for Alternative 3 (SWAC goal of 75 ng/kg) and accounts for post-dredging capping and solids release, yields a post-remedy concentration of 70 ng/kg.

Projections accounting for post-dredging capping and assuming 3 percent resuspension were made for all alternatives except Alternative 5. The 10-year post-remedy concentrations of these projections are shown in Table 7. Also shown in this table are computed recovery half times assuming the remedies achieve their post-remedy 2,3,7,8-TCDD attainment goals and concentrations follow a first order decay. The point of presenting these results is to assess whether source control accelerates recovery. The degree of acceleration is less reliable since it differs across model scenarios and relies on the presumption that the SWAC goal is the concentration attained at remedy completion.

Table 7
Post-Remedy 2,3,4,8-TCDD Half-Times Estimates

Alternative	Post-Remedy Attainment Goal for 2,3,7,8-TCDD SWAC (ng/kg)	Model Predicted 2,3,7,8-TCDD RM 8.3 to RM 15 SWAC 10 years Post-Remedy (ng/kg)	Recovery Half-Time (yrs) if Design SWACs are Met at Remedy Completion
1	--	615	43[a]
2	85	53	14
3	75	48	15
4	65	42	16

Note:
a. Based on predicted concentration of 722 ng/kg in year 8 of the projection.

[18] Half-times are here calculated from the predicted concentration at the end of year 8 (when all IR alternatives are complete) and the predicted concentration 10 years later (end of year 18), assuming a first order decay.

Alternatives 2, 3, and 4 are projected to accelerate the rate of recovery relative to the NFA alternative.[19] This result is consistent with the results for the source control metrics presented earlier. Source control greatly reduces the 2,3,7,8-TCDD concentration on depositing particles, thereby enhancing recovery rate. The minimal differences in depositing particle concentration among Alternatives 2, 3, and 4 result in minimal differences in recovery rate. Interestingly, the slightly lower 10-year post-remedy concentrations of Alternatives 3 and 4 relative to Alternative 2 have little bearing on recovery rate (the slightly higher recovery rate of Alternative 2 is within the uncertainty of the estimate). Also noteworthy is that the differences in predicted concentration among the alternatives are about half the 10 ng/kg difference per alternative presumed to exist at remedy completion.

2.2.4 Net Flux to the Lower 8.3 Miles

The effectiveness of the IR at reducing the influence of RM 8.3 to RM 15 sediment sources on the lower 8.3 miles of the LPR is presented in Figure 4 which shows the cumulative 2,3,7,8-TCDD flux (load) passing RM 8.3. As shown in the RI report, there is currently a fairly steady net downstream 2,3,7,8-TCDD flux during low flow conditions when tidal currents dominate, and the flux can increase sharply during high freshwater flow events that erode the bed. The cumulative flux in Figure 4a integrates over the full range of flow conditions in the simulated 10-year post-remedy period and thereby quantifies the aggregate export of contaminant from the upper river sediment source.

The net downstream flux at RM 8.3 responds to the IR alternatives in a way that reflects the reductions in gross erosion flux to the water column. Relative to the NFA scenario (Alternative 1), Alternative 5 reduces the downstream flux at RM 8.3 from 5 to 0.91 g/y (82%) and Alternative 2 further reduces it by an additional 0.04 g/y. Alternative 3 achieves an additional 0.05 g/y reduction whereas Alternative 4 yields no further reduction (actually a very slight increase, presumably reflecting the timing of dredge resuspension effects). Thus, most of the source control is achieved by the Alternative 5 RAL of 346 ng/kg, and further reductions in the RAL yield marginal benefit in reducing the total 2,3,7,8-TCDD load to the lower river. This analysis also supports the IR FS conclusion that Alternatives 2, 3, and 4 provide equivalent degrees of long-term effectiveness and permanence.

2.2.5 Water Column Concentration

The source control achieved by the IR alternatives in comparison to the NFA alternative is further assessed in Figure 4b, which shows the reduction of average water column 2,3,7,8-TCDD concentrations in RM 8.3 to RM 15 over the 10-year post-remedy period. This quantity is a relevant measure of the degree of sediment source control because it integrates the influence of the erosion flux discussed above while accounting for contaminant losses due to deposition and the net downstream transport to the lower river. The resulting water column concentration represents the exposure concentration to pelagic biota resulting from sediment sources.

[19] The projections that do not account for solids release and capping show less acceleration but are not used here because the influence of resuspension persists 10 years post-remedy, which also influences the relative comparisons among alternatives. A sense for the differences was developed by linearly extrapolating Alternative 3 10 years post-remedy concentrations to 0% resuspension from 1% and 3%, which yields 57 ng/kg. Assuming 75 ng/kg is attained, the half time is 26 years.

The performance of the alternatives in reducing the post-remedy water column 2,3,7,8-TCDD concentration is consistent with prior conclusions regarding the erosion flux; the smallest of the active remedy alternatives (Alternative 5) achieves substantial source control while further reductions of the RAL have a progressively smaller impact on water column concentrations in RM 8.3 to RM 15. Relative to the NFA scenario (Alternative 1), Alternative 5 reduces the mean concentration by about 73% (from 1.5 to 0.39 picogram per liter [pg/L]) and Alternative 2 provides a slight further reduction of 0.024 pg/L. Alternatives 3 achieves an additional reduction of 0.015 pg/L whereas Alternative 4 yields no further reduction. The marginal improvement in water column concentration offered by the larger alternatives is consistent with a relatively small influence of the lower concentration sediments that are added to the remedial footprint as the RAL is dropped below that of Alternatives 5 and 2. Similar to other metrics, this analysis shows that Alternatives 2, 3, and 4 achieve an equivalent degree of long-term effectiveness and permanence.

2.3 Conclusions

Alternative 2 achieves the IR FS metrics for the threshold criteria for remedial alternative evaluation under the NCP, with the ability to progress towards overall protection of human health and the environment, the ability to achieve the RAOs, and the ability to comply with ARARs.[20] As shown by the detailed evaluation using the objective metrics, its long-term effectiveness and permanence are equivalent to that achieved with Alternatives 3 and 4.

Alternative 2 ranks higher than the other alternatives for the NCP criteria of short-term effectiveness and implementability. Alternatives 3 and 4 have greater short-term impacts to workers and the community because of the larger removals, which also compound the significant implementation challenges of dredging in the upper 9 miles.

Alternative 2 achieves the source control RAOs and is the most cost-effective, achieving all the objectives of the IR for the lowest cost. The additional remediation and costs for Alternatives 3 and 4 (5% to 12% higher costs than Alternative 2, respectively) do not result in significant additional source control over Alternative 2. Together with the implementation of the lower 8-mile remedy, an IR in the upper 9 miles based on Alternative 2, 3, or 4 is expected to promote significant river-wide recovery, with the degree of overall recovery expected to be similar for all these active alternatives.

Relative differences among sediment removal volumes, estimated present-value costs, and reduction in 2,3,7,8-TCDD gross erosion flux for Alternatives 2, 3, and 4 are summarized as follows:

[20] Water quality ARARs may not be achieved under any of the IR alternatives, which would necessitate a Technical Impracticability waiver. A final ROD would address remaining site risks for surface water.

Table 8
Estimated Volume Dredged, Total Cost, and Reduction in Gross Erosion Flux for Alternatives 2, 3, and 4

Alternative	Estimated Volume Removed		Estimated Cost		Estimated Reduction of Gross Erosion Flux	
	k yd^3	Increase from Alt 2	$ MM	Increase from Alt 2	Relative to NFA	Increase from Alt 2
2 (85 ppt)	363	-	412	-	79.6%	-
3 (75 ppt)	387	7%	433	5%	80.6%	1.3%
4 (65 ppt)	419	15%	460	12%	80.8%	1.5%

In conclusion, the CPG recommends Alternative 2 for selection as a source control IR for the upper 9 miles of the LPRSA. It achieves the RAOs without unnecessary additional removal of sediments, minimizes the short-term impacts and implementability challenges, and is the most cost-effective alternative.

3 RAO 1 Should be Changed: The Non-Measurable Objective of Achieving a SWAC Should be Replaced with the Measurable Objective of Remediating All Actionable Sediments at or Above a RAL

Throughout the course of developing the IR FS, it has become increasingly clear that there are substantial technical issues with the RAO 1 goal of achieving a post-remedy SWAC, both as a measurable objective on which USEPA can certify Remedial Action Project Completion and, equally important, as an objective that is compatible with the goal of controlling internal sources of 2,3,7,8-TCDD and total PCBs to promote accelerated recovery in the upper 9 miles of the LPRSA. During preparation of the IR FS, the CPG identified these shortcomings with RAO 1 and raised them with USEPA and NJDEP for further consideration. RAO 1 should be revised to include a RAL goal instead of a SWAC goal.

The 2,3,7,8-TCDD concentration of 85 ng/kg and the total PCB concentration of 0.46 mg/kg that are specified as SWAC objectives in RAO 1 are not definitive source control goals. The source control goal is to actively remediate sediments lacking high recovery potential as evidenced by concentrations significantly above those on depositing particles. Achieving this goal will greatly reduce the SWACs for 2,3,7,8-TCDD and total PCBs. However, with the currently available data we cannot precisely estimate the post-remedy SWACs that will be attained by source control, nor is it likely that the SWAC can be measured with sufficient certainty following IR implementation to determine whether or not the RAO 1 SWAC targets were attained.

The inability to precisely define the post-remedy SWACs that will be attained by the IR derives from the considerable uncertainty in the distribution of concentrations in the river sediments. This is evident in the differences among concentration maps that were developed to take account of uncertainty. The 100 conditional simulation maps developed for the IR FS using geostatistical simulation were each sampled at 80 feet-on-center to simulate a remedial design sampling program. Thiessen polygons around each point were remediated if the total PCB concentration was at or above 1 mg/kg or the 2,3,7,8-TCDD concentration was at or above 300 ng/kg. Areas were added in a similar fashion to satisfy RAO 2 (by remediating points in erosional areas with subsurface concentrations at or above twice the surface RALs). The post-remedy SWAC was computed using the map concentrations in unremediated areas and an assumed concentration in remediated areas of 10 ng/kg for 2,3,7,8-TCDD and zero for total PCBs. The 100 conditional simulations generated areas subject to active remediation between 73 and 97 acres. The post-remedy 2,3,7,8-TCDD SWACs varied between 75 and 110 ng/kg (Figure 5) and the post-remedy total PCB SWACs varied between 0.27 and 0.33 mg/kg. This evaluation illustrates how the post-remedy SWAC is not directly tied to the thresholds for sources.

The significant shortcomings of attempting to define the post-remedy SWACs are also illustrated by USEPA's recently presented analysis indicating that as many as 2,400 locations may have to be sampled to achieve a high probability of declaring success when the SWAC goal is achieved and an appropriately high probability of declaring failure when the true post-IR mean is greater than Y times the SWAC (where Y was 1.5) That would be a sampling density of almost 10 locations per acre, which exceeds even the high density sampling contemplated for designing the remedy.

Following the high-density sediment sampling of the river to be conducted during remedial design (i.e., the Pre-Design Investigation or PDI), there will be a more precise understanding of the relationship between a threshold for remediation (i.e., a RAL) and the expected post-remedy SWAC. Nevertheless, the RAL-SWAC relationship will be subject to the uncertainty of the post-remedy concentrations in remediated areas and whether remediation has altered the concentrations in unremediated areas.

In contrast to the inherent uncertainty of the post-remedy SWAC, the pre-remedy concentration distribution will be well defined after the PDI. The high-density sediment sampling that will be performed during the PDI will provide an accurate identification and delineation of the areas that exceed a RAL. Remediating these areas and post-remedy sampling to confirm that all actionable areas above the RAL have been remediated provides assurance that the objective of source control has been achieved regardless of the resulting post-remedy SWAC.

Whether or not the post-remedy SWAC values meet the values currently in RAO 1 does not inform whether source control has been attained. Review of the 100 maps mentioned above showed that the SWAC goals can be achieved with a significant fraction of the upper 9 miles of the river still above source control RALs. Conversely, the entire 9-mile reach can be below source control RALs and the SWAC goal is not achieved; this outcome would be most likely if resuspension caused persistent low-level recontamination.

Further, as discussed below in Section 4, post-remedy sampling will provide a highly imprecise estimate of SWAC. Simulations conducted by USEPA have shown that a sampling program targeting as many as 400 locations will yield 2,3,7,8-TCDD SWAC estimates whose uncertainty can be as high as the estimate itself (e.g., a SWAC estimate of 80 ng/kg might have an uncertainty interval that stretches from 40 ng/kg to 120 ng/kg).[21] This wide band of uncertainty precludes or prevents attempts to judge whether the SWAC goals have been achieved, and there is a high likelihood that there will be false conclusions about whether or not the SWAC goal was achieved. This has the potential to interfere with USEPA's ability to reach a determination of remedial action project completion for the IR.

The first sentence of RAO 1 defines the correct and attainable goal for the source control IR:

> Control the sediment sources of 2,3,7,8-tetrachlorodibenzodioxin (TCDD) and total polychlorinated biphenyls (PCBs) by remediating surface sediment source areas containing elevated concentrations, thereby reducing the surface weighted average concentrations (SWACs) of 2,3,7,8-TCDD and total PCBs from river mile (RM) 8.3 to RM 15.

The goal of the IR is to identify and control sources of sediment that are preventing the recovery of the river. The definition of the goal, and the determination that the goal has been achieved should be

[21] Inferred from Slide 5 of the USEPA Region 2 July 10, 2019 presentation at an FS meeting attended by USEPA Region 2, NJDEP and the CPG held at USEPA Region 2 Office in Edison, NJ.

established in a manner that is implementable and measurable with the highest degree of certainty achievable. A SWAC of 85 ppt 2,3,7,8-TCDD is arbitrary as a bright line for exposure reduction or source control. It does not establish a goal that provides any basis for determining whether ongoing recovery will ultimately attain final remedial goals or additional actions are required. The SWACs defined for source control in RAO 1 are not absolute thresholds for source control nor are they thresholds needed to achieve accelerated longer-term recovery. A post IR SWAC cannot definitively be established with post IR sediment sampling and is not a reliable or sound metric to measure IR completion.

In summary, a RAL is a superior and measurable metric that should be used for RAO 1 for the following reasons:

- A RAL is directly tied to attaining source control and can be set based on PDI data and system understanding.
- Targeting a RAL based on the PDI data ensures source control and increases the likelihood of a successful source control IR.
- Achievement of a RAL at the completion of the source control IR can be confirmed with a higher degree of certainty than a SWAC.

USEPA should reconsider and revise RAO 1 to remove the post-IR SWAC goal and replace it with a RAL as the basis for determining IR completion. The SWAC goal of a chosen remedy provides a basis during design to establish the RAL whose attainment can be confirmed with post-remedy sampling.

4 If RAO 1 is Not Changed, the Process to Evaluate Post-Remedy SWAC Should be Generally Consistent With That Presented by USEPA on July 24, 2019

According to IR FS RAOs, control of internal sources will be accomplished by: 1) remediating sediments with surface layer (top 6 inch) total PCB concentrations of 1 mg/kg or higher or 2,3,7,8-TCDD concentrations at or above a threshold established to achieve the 85 ng/kg SWAC goal; and 2) remediating sediments vulnerable to erosion and having subsurface (0.5 to 1.5 feet below the bed surface) total PCB concentrations of 2 mg/kg or higher or 2,3,7,8-TCDD concentrations at or above two times the threshold established to achieve the surface layer 85 ng/kg SWAC goal.

The CPG has laid out processes to ensure conformance with the RAOs. The first of these is accurate mapping of sediment total PCB and 2,3,7,8-TCDD concentrations and areas vulnerable to erosion. A multi-stage PDI will be conducted. The first stage will consist of sampling on a fixed grid nominally spaced at 80-feet on center. Geostatistical interpolation will be conducted to establish an initial remediation footprint that achieves the SWAC goals. Additional rounds of sampling will be conducted to address areas where the remediation boundaries are most uncertain and geostatistical interpolation will be repeated with the more fulsome dataset to refine the remediation footprint. Physical characteristics (i.e., geotechnical properties, sediment type, bathymetry, and hydrodynamic conditions) will be incorporated into the delineation of remediation areas to allow for consideration of elements that can impact where contamination may (or may not) exist based on the characteristics of the river. The geostatistical evaluation can incorporate some of these features, but manual review of those results to optimize the target areas and incorporate physical information will help with developing a robust remedial prism. To identify areas vulnerable to erosion, a bank-to-bank bathymetric survey will be conducted for comparison to the 2019 baseline conditions survey. Using bathymetric differencing, vulnerable areas will be defined and PDI data and geostatistical mapping in those areas will be used to expand the remediation footprint where appropriate.

The second process to ensure source control is a comprehensive remedial design. The design will include careful consideration of dredge slope stability, cut thickness, material handling, offsets from physical structures and infrastructure, and other operational constraints to minimize concerns with undisturbed and generated residuals near structures and on potentially unstable slopes. The design will incorporate elements to control the impact of resuspension. A constructability peer review will be conducted with experienced design and construction personnel that were not directly involved with development of the design.

The third process is careful implementation of the remedy. The procurement phase will include a thorough vetting of contractors understanding of the project, experience/capabilities, and ability to adaptively manage construction. A rigorous certification process will be established to evaluate the various elements of implementation (dredging, cap placement). This process will assess attainment of cut lines and successful placement of the isolation, filter, and armor layers of caps, and it will involve review and sign off by USEPA oversight personnel. Solids and contaminant release during implementation will be subject to performance standards and operational adjustments if the standards are not being met.

The performance of the above processes provides important evidence to assess whether active remediation has achieved its source control objective. They are the first three Lines of Evidence (LOE) in assessing remedy completion.

A more uncertain assessment is whether the post-remedy SWACs are at or below the RAO 1 goals of 85 ng/kg for 2,3,7,8-TCDD and 0.46 ng/kg for total PCBs. Sediment sampling data will provide a sense of the range within which the true SWAC likely exists, but not a more definitive understanding of it. USEPA has concluded that the uncertainty inherent in the SWAC estimates is tolerable because the SWAC goals are not absolute thresholds for source control or acceleration of long-term recovery. One illustration of this fact is the uncertainty of the 2,3,7,8-TCDD SWAC that results from addressing sources defined as sediments with concentrations at or above 300 ng/kg. Across the 100 maps of concentration developed using conditional simulation, SWACs consistent with addressing these defined sources could be as low as 75 ng/kg or as high as 110 ng/kg (Figure 5).

Lacking the ability to accurately measure the true SWAC, USEPA has focused on the use of statistical testing to ensure that the uncertainty does not allow for a true SWAC beyond what is reasonably equivalent to the goal. In conformance with its guidance, USEPA has proposed that attainment of RAO 1 SWAC goals will be assessed by comparing the 95% upper confidence limits (UCLs) of the post-IR SWACs to values that are Y times the goals. The Y-factor establishes the accepted reasonable degree of equivalence. If the 95% UCLs are less than or equal to Y times the goals, the IR would be considered to have met the SWAC goals with an appropriate degree of statistical confidence. The Y value will be set such that the expected frequency of false negatives (i.e., concluding the SWAC goals were not achieved when they were) is not more than 5%. Note that in principle different Y-factors can be established for 2,3,7,8-TCDD and total PCBs. The statistical testing forms a fourth LOE in assessing remedy completion.

A fifth and final LOE, to be evaluated if the statistical testing under LOE 4 is indeterminate, relates to the examination of the post-remedy sediment data for evidence of additional potential source areas. Such indication would be spatial structure suggesting a contiguous area of elevated concentrations that might constitute a potential unaddressed source. The results of this fifth LOE would be factored into a weight-of-evidence assessment of remedy completion.

The CPG, in general agreement with USEPA's July 2019 decision tree narrative for IR completion, advocates the multi-step LOE evaluation framework embodied in the decision tree presented in Figure 6 for 2,3,7,8-TCDD. The first step compares the 95% UCLs to the limiting values established during remedial design (i.e., Y times the target SWACs). Finding them to be at or below the limiting values will constitute remedy completion.

If either of the 95% UCLs exceed the limiting values, a second round of sediment sampling will be conducted to supplement the post-IR dataset so that refined 95% UCLs can be compared to the limiting values. Finding them to be at or below the limiting values will constitute remedy completion.

If either of the newly established 95% UCLs exceed the limiting values, the 95% lower confidence limits (LCLs) will be compared to the SWAC goals. If both are at or below the SWAC goals, the statistical testing will be deemed indeterminate and a weight-of-evidence approach will be applied such that the other four LOEs will be examined, including the fifth line of evidence that evaluates whether there is evidence of potential source areas in the post-IR dataset. The two rounds of post-remedy data should be adequate for this assessment given that they will likely yield a density of multiple samples per acre. If the LOE examination supports that the remedy has been successfully implemented, the conclusion will be that although the statistics are indeterminate, the IR construction is considered complete. Otherwise, the remedy will be deemed to not be conclusively complete.

If the IR is deemed to not be conclusively complete, investigations will be conducted to more fully evaluate whether actionable sources exist. Factors to be considered in the evaluation include:

- Contaminant mass
- Potential for erosion
- Potential for natural recovery

If actionable source areas are not identified, the remedy will be deemed complete by weight of evidence. If actionable source areas are identified, a supplemental FS will be performed to evaluate potential additional remediation.

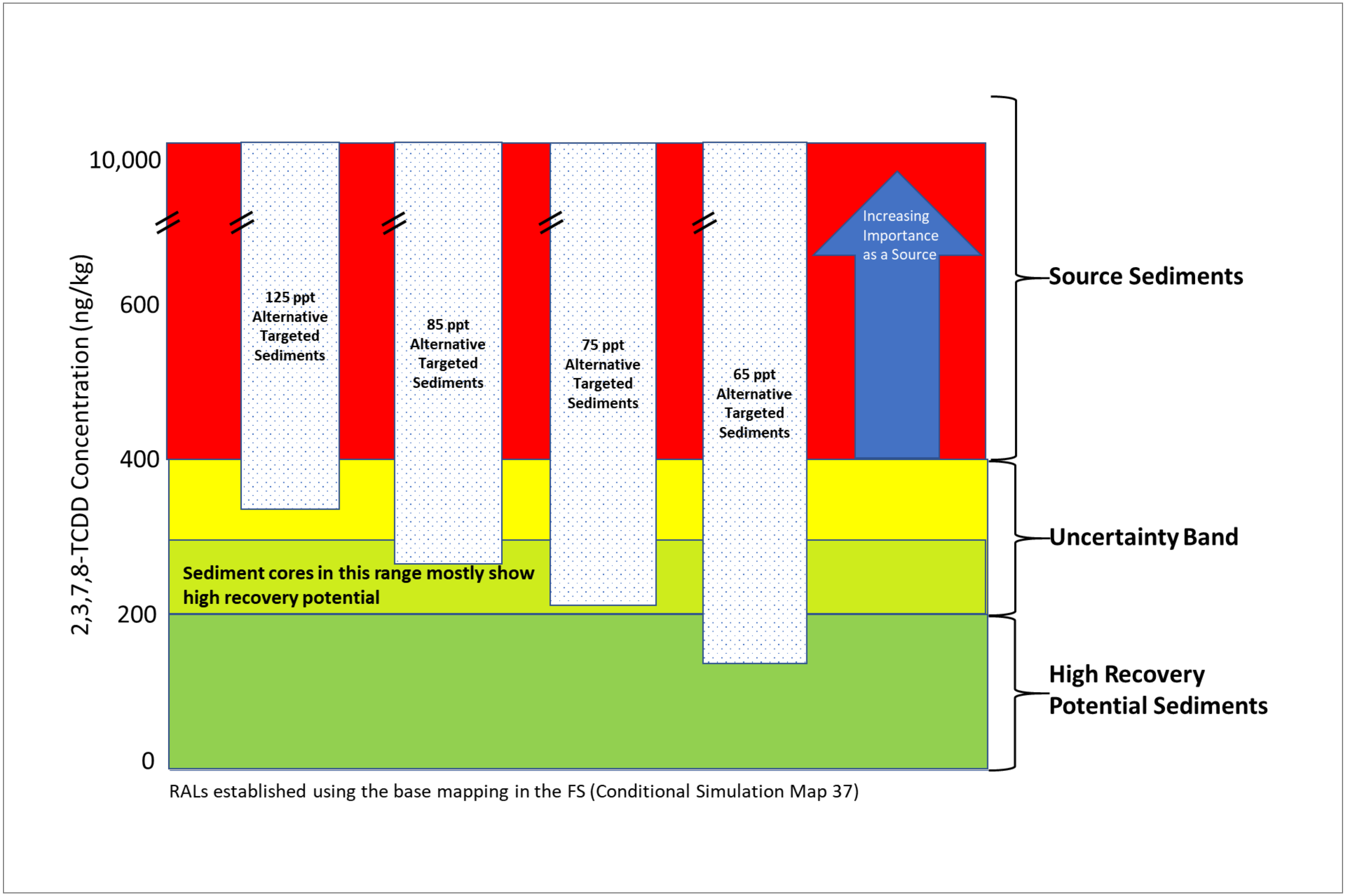

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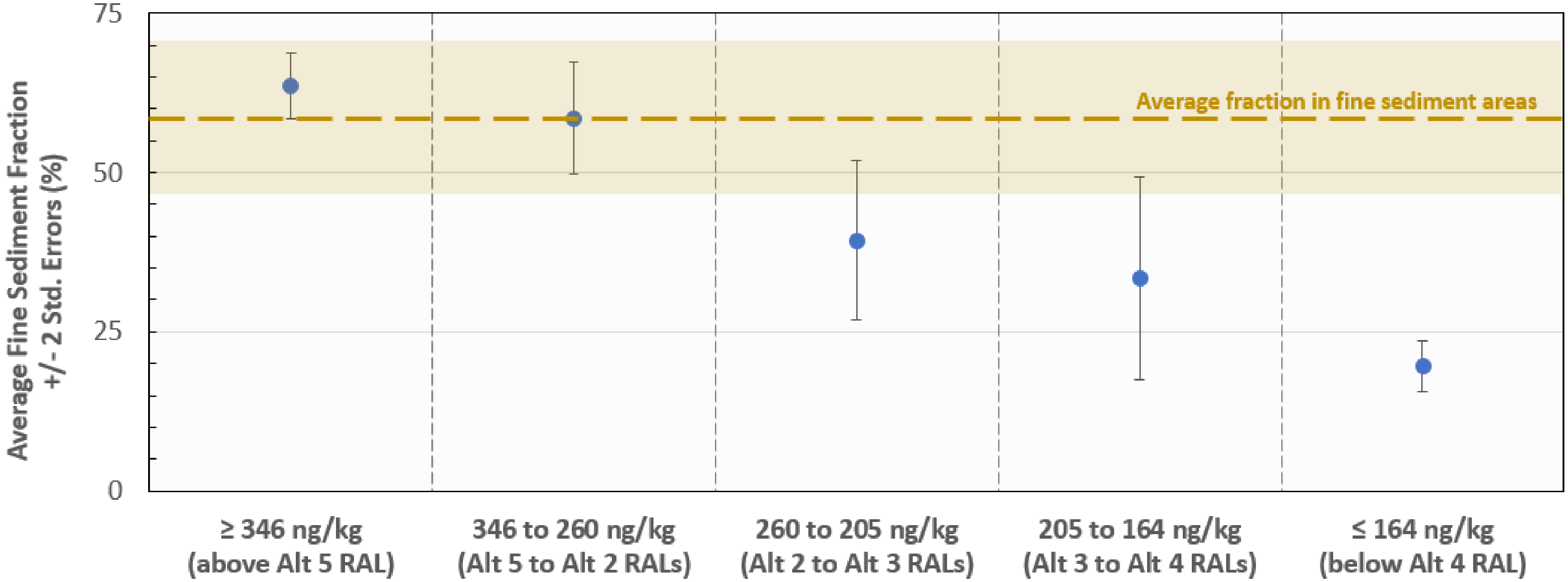
Figure 1

Illustration of Remedial Alternatives Targeting the Categories of Sediment

Cooperating Parties Group NRRB/CSTAG Statement

Lower Passaic River Study Area



Notes:
Average fine sediment fraction of surface samples from RM 8.3 to RM 15 with 2,3,7,8-TCDD concentration within bins defined by the RALs for the FS alternatives as delineated on the FS basemap (CS 37).
The dashed line indicates the mean fine sediment fraction of samples collected in areas designated to be fine sediments by both the RI/FS definition (based mainly on the 2005 side-scan sonar survey) and the 2019 side-scan sonar survey. The yellow band indicates two standard errors about that mean.

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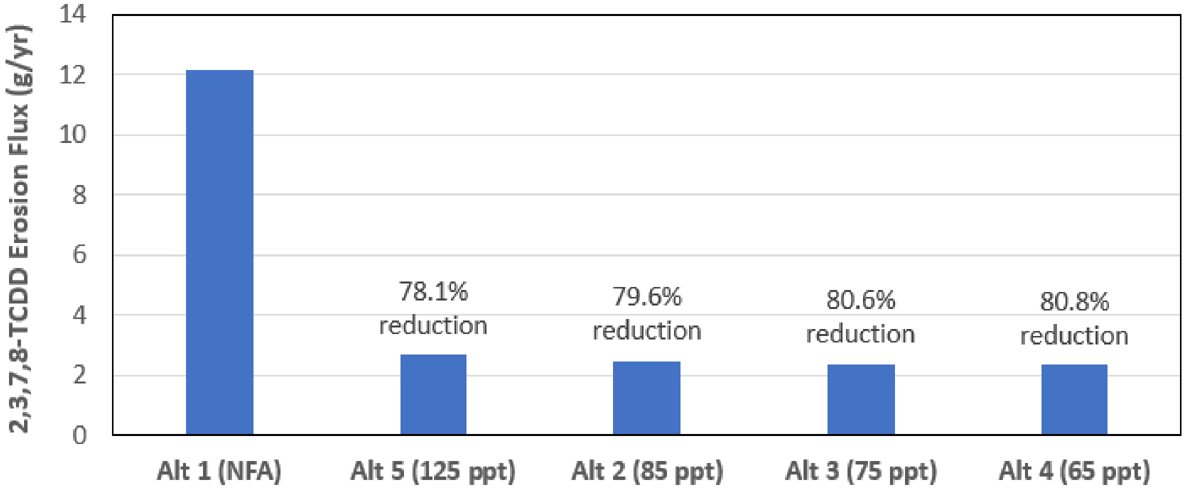
Figure 2
FS Alternative RALs Target Sediments with a Progressively Lower Fine Sediment Content

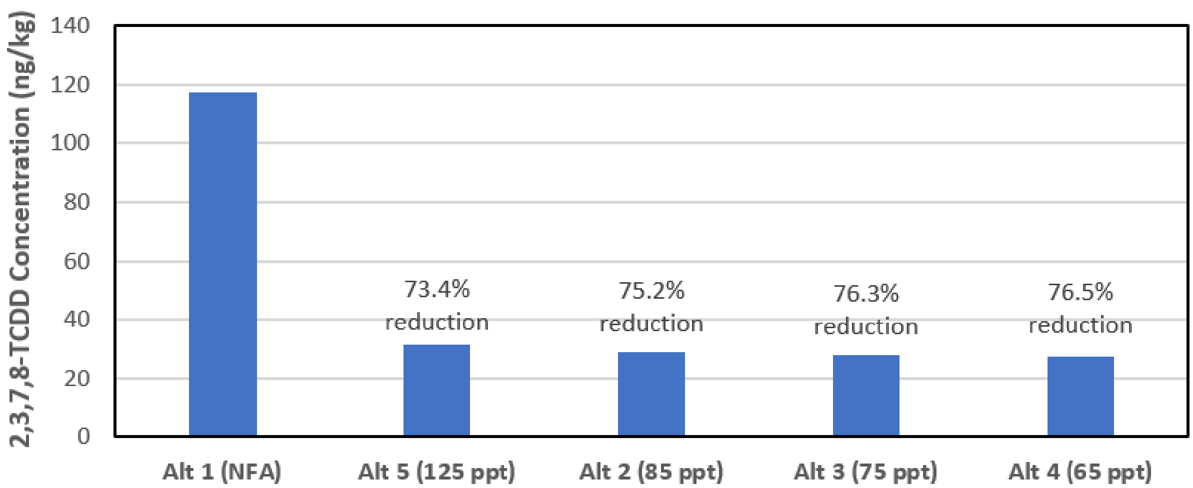
Cooperating Parties Group NRRB/CSTAG Statement
Lower Passaic River Study Area

a)



Note: Based on total flux over the 10-year post-remedy period in the base FS model projections.

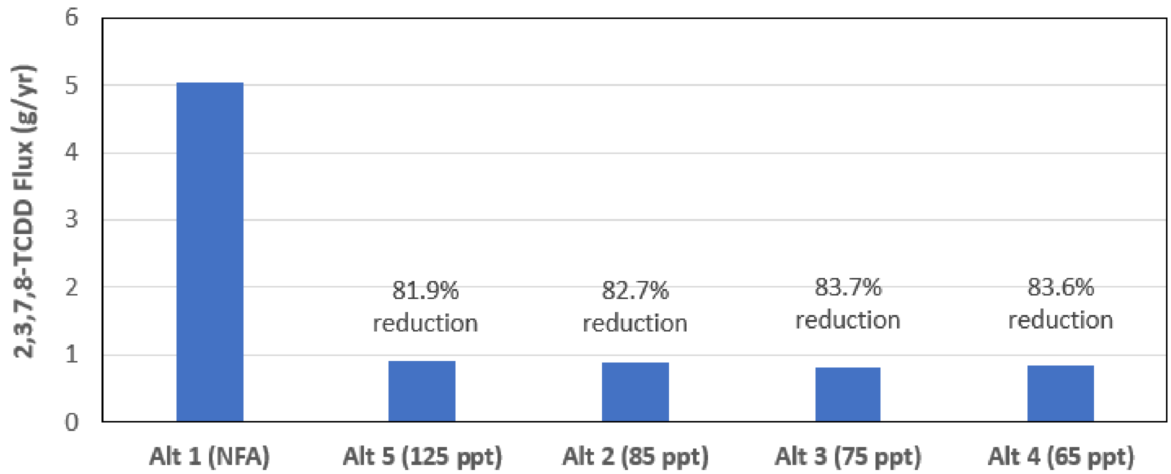
b)



Note: The concentration on depositing fine (cohesive) particles was computed as the ratio of the total chemical deposition flux to the total fine sediment deposition flux over the 10-year post remedy period.

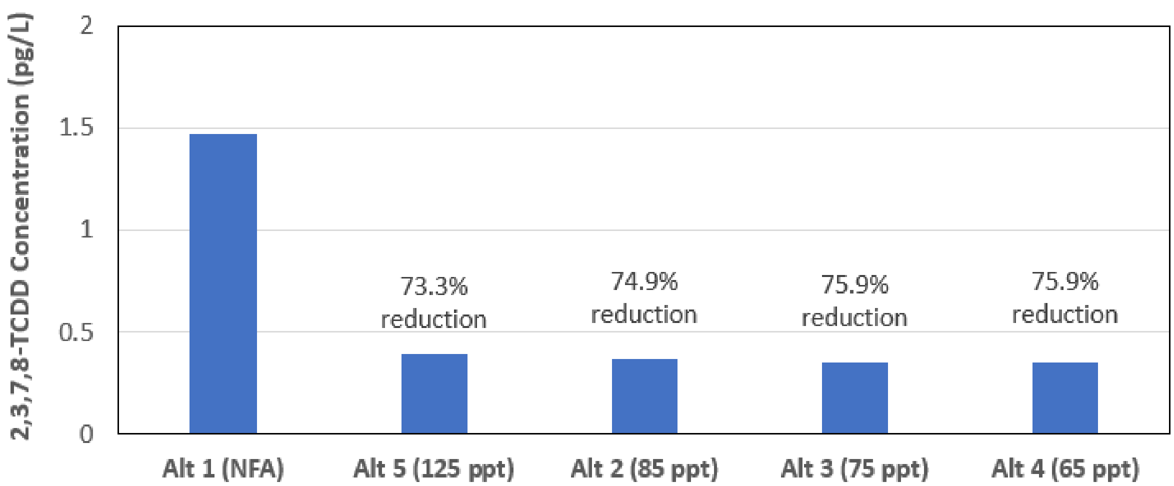
Figure 3
Post-Remedy 2,3,7,8-TCDD Erosion Flux from RM 8.3 to RM 15 Sediments and Average 2,3,7,8-TCDD Concentration on Depositing Fine Sediments in RM 8.3 to 15

a)



Note: Based on total net flux at RM 8.3 over the 10-year post-remedy period in the base FS model projections.

b)



Note: Mean RM 8.3 to RM 15 concentration over the 10-year post-remedy period in the base FS model projections.

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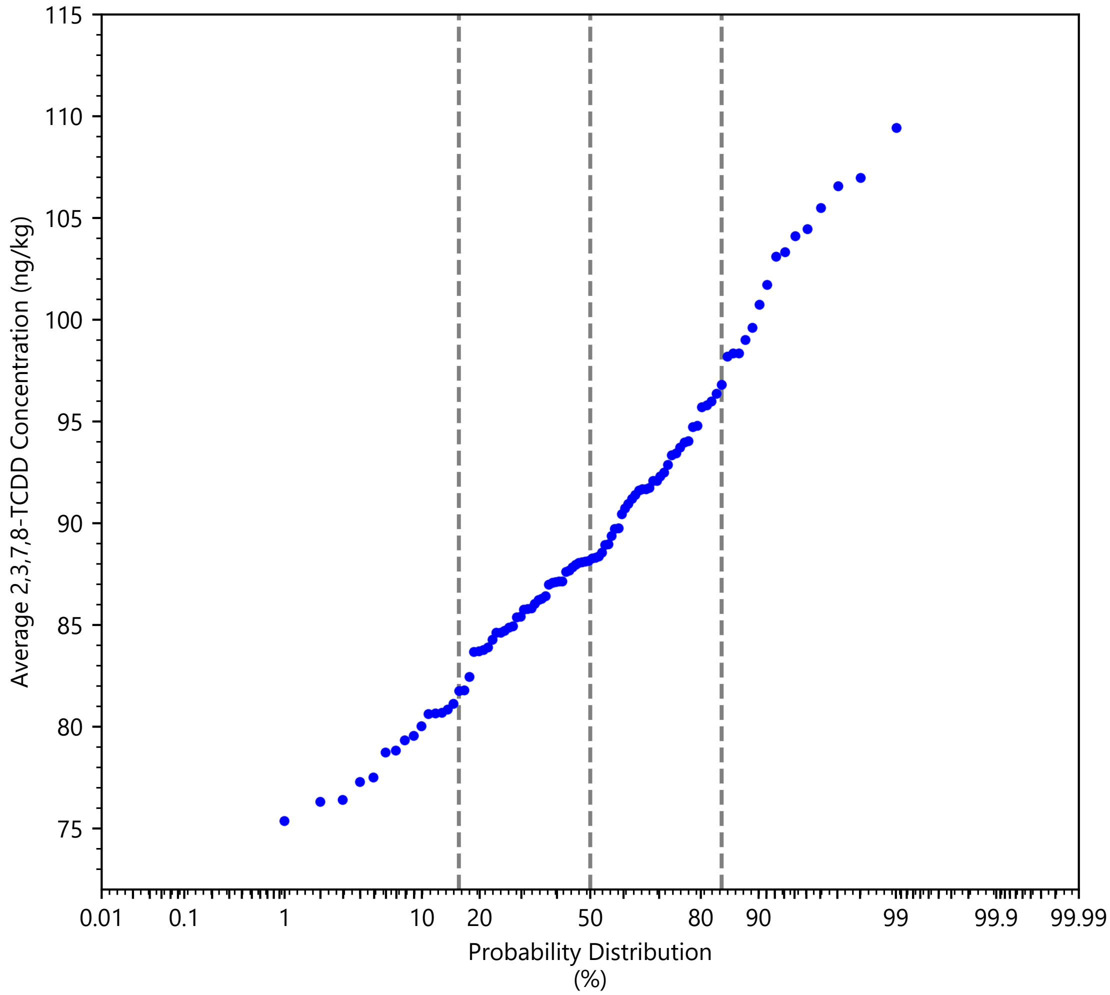
Figure 4
Post-Remedy Net Downstream 2,3,7,8-TCDD Flux at RM 8.3 and Average Water Column 2,3,7,8-TCDD Concentration in RM 8.3 to 15



Notes: Delineation includes a total PCB RAL of 1 mg/kg, a 2,3,7,8-TCDD residual concentration of 10 ng/kg, and RA02 targeting using a subsurface RAL multiplier of 2x and the hybrid model/data erosional area definition with an erosion cutoff of 15 cm.

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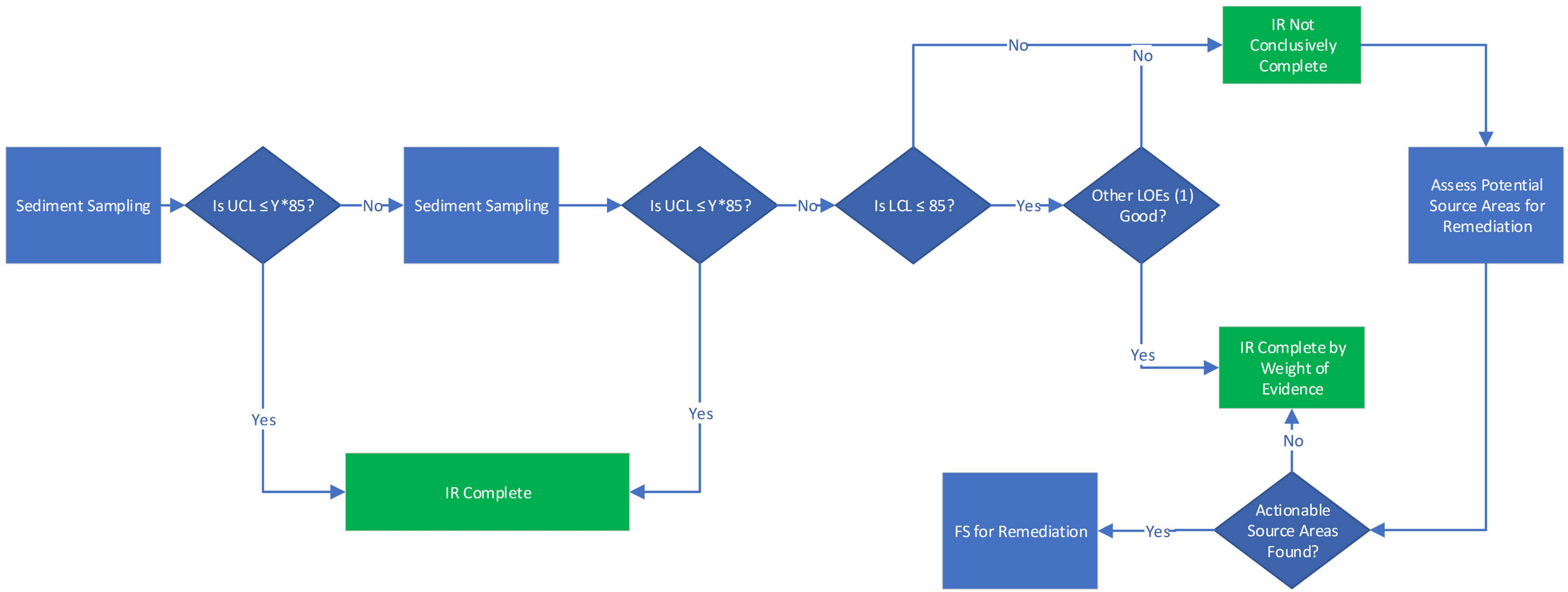
Figure 5
Distribution of Post-remedy Surface 2,3,7,8-TCDD SWACs for 100 Conditional Simulations Based on a RAL of 300 ng/kg



(1) Other LOEs include mapping, remedy design, remedy implementation and post-IR data assessment

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Figure 6

2,3,7,8-TCDD Decision Tree for Remedy Completion Determination

Cooperating Parties Group CSTAG/NRRB Statement
Lower Passaic River Study Area